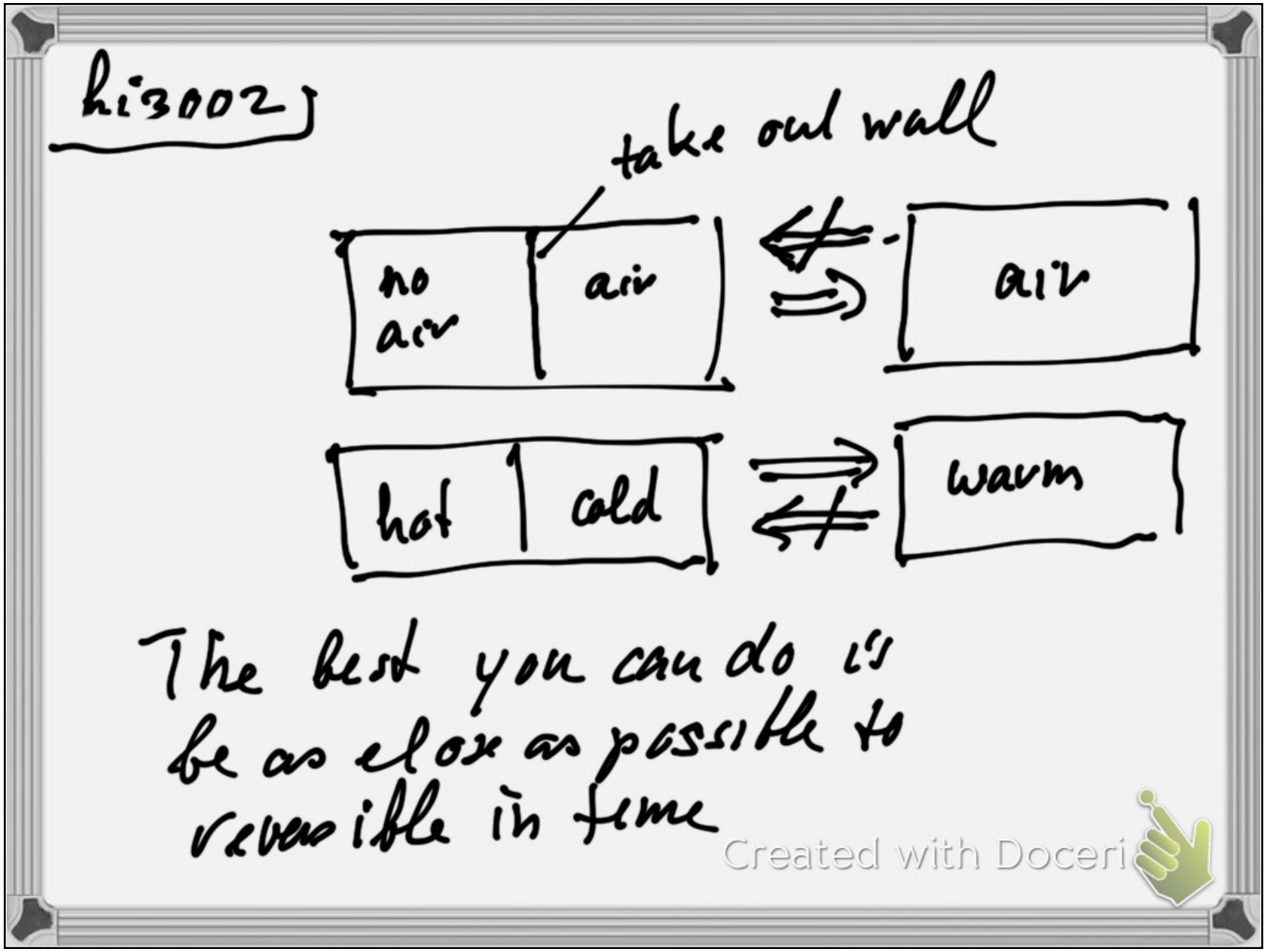
hi3002
take out wall
no air
air
air
hot
cold
warm
The best you can do is be as slow as possible to reversible in time
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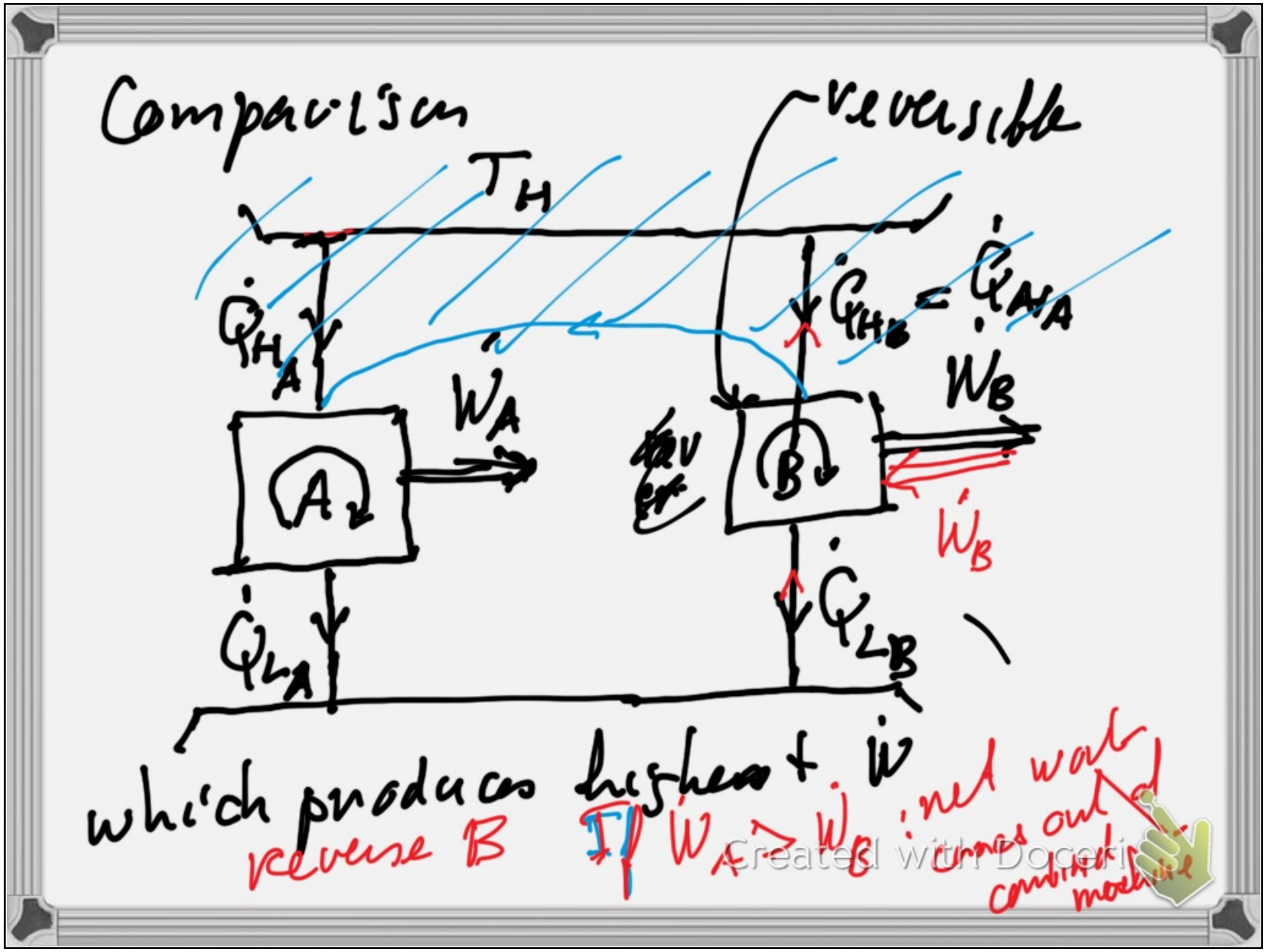
Comparison
reversible
T_H
$\dot{Q}_{H_A}$
W_A
A
$\dot{Q}_{L_A}$
$\dot{Q}_{H_B} = \dot{Q}_{H_A}$
W_B
B
$\dot{W}_B$
$\dot{Q}_{L_B}$
which produces
reverse B
If $\dot{W}_A > \dot{W}_B$: net work
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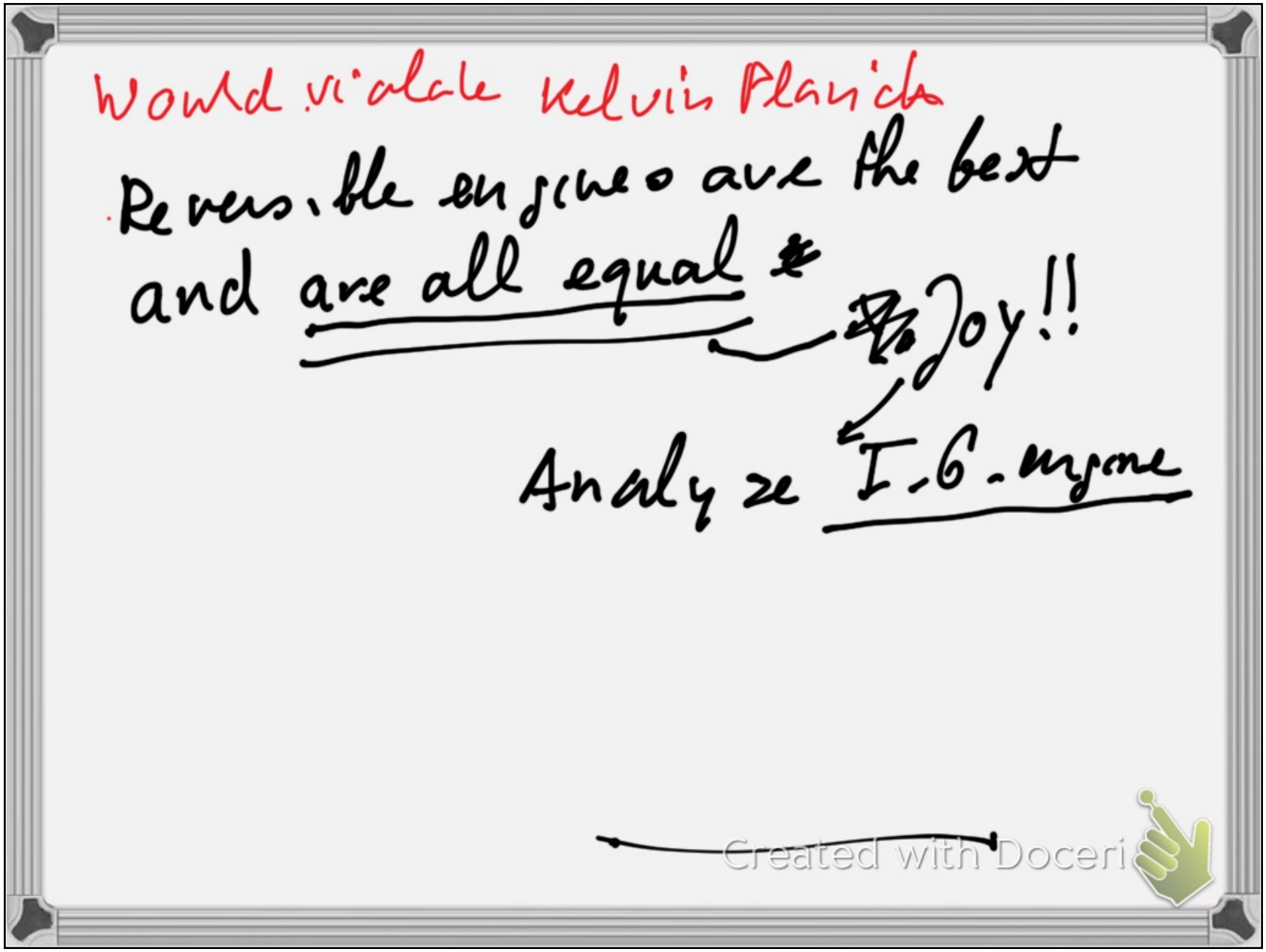
Would violate Kelvin Planck
Reversible engines are the best
and are all equal &
Enjoy!!
Analyze I.C. engine
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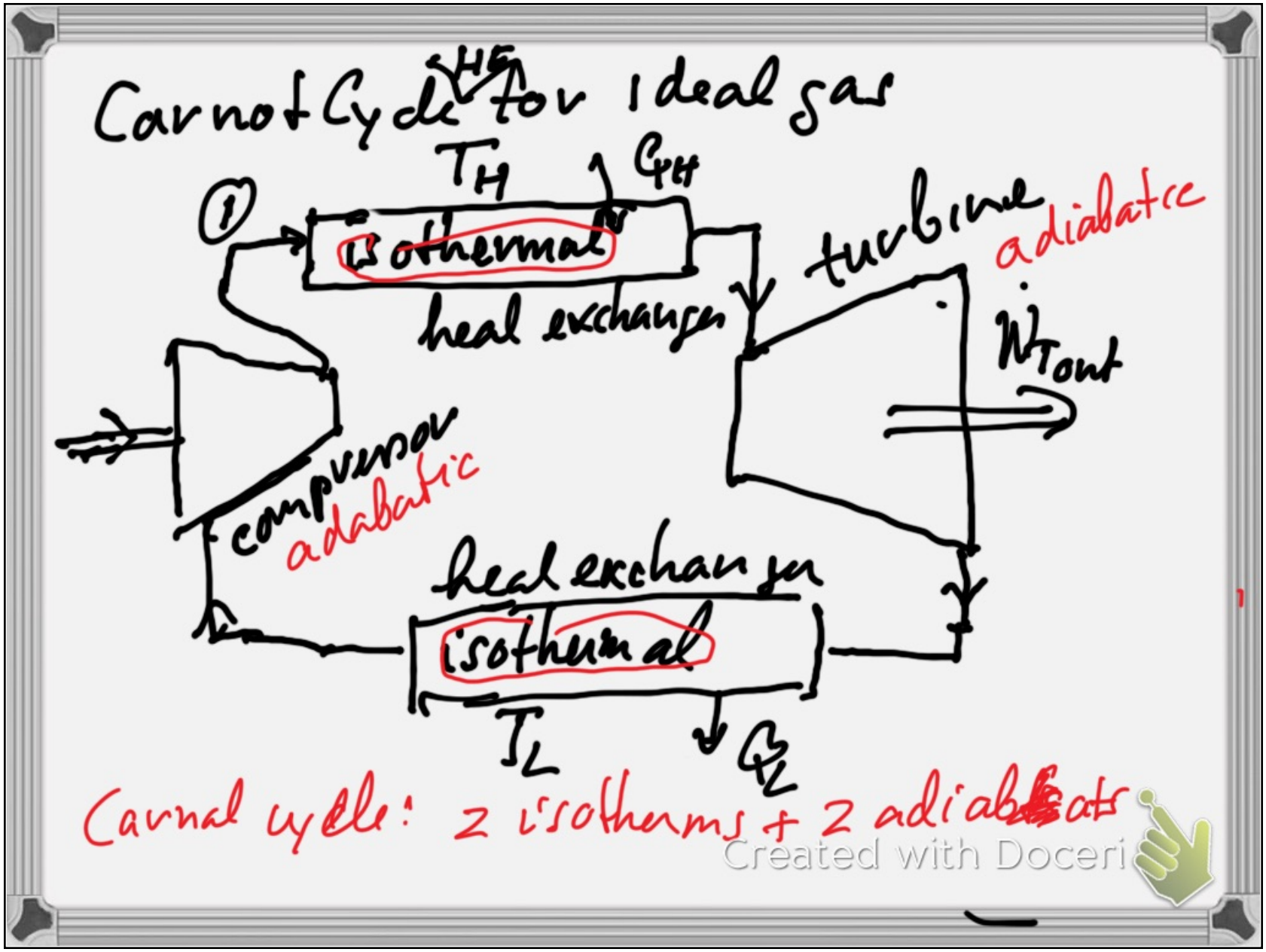
Carnot Cycle for ideal gas
HE
T_H
Q_H
1
isothermal
heat exchanger
turbine
adiabatic
$\dot{W}_{T\,out}$
compressor
adiabatic
heat exchanger
isothermal
T_L
Q_L
Carnal cycle: 2 isotherms + 2 adiabats
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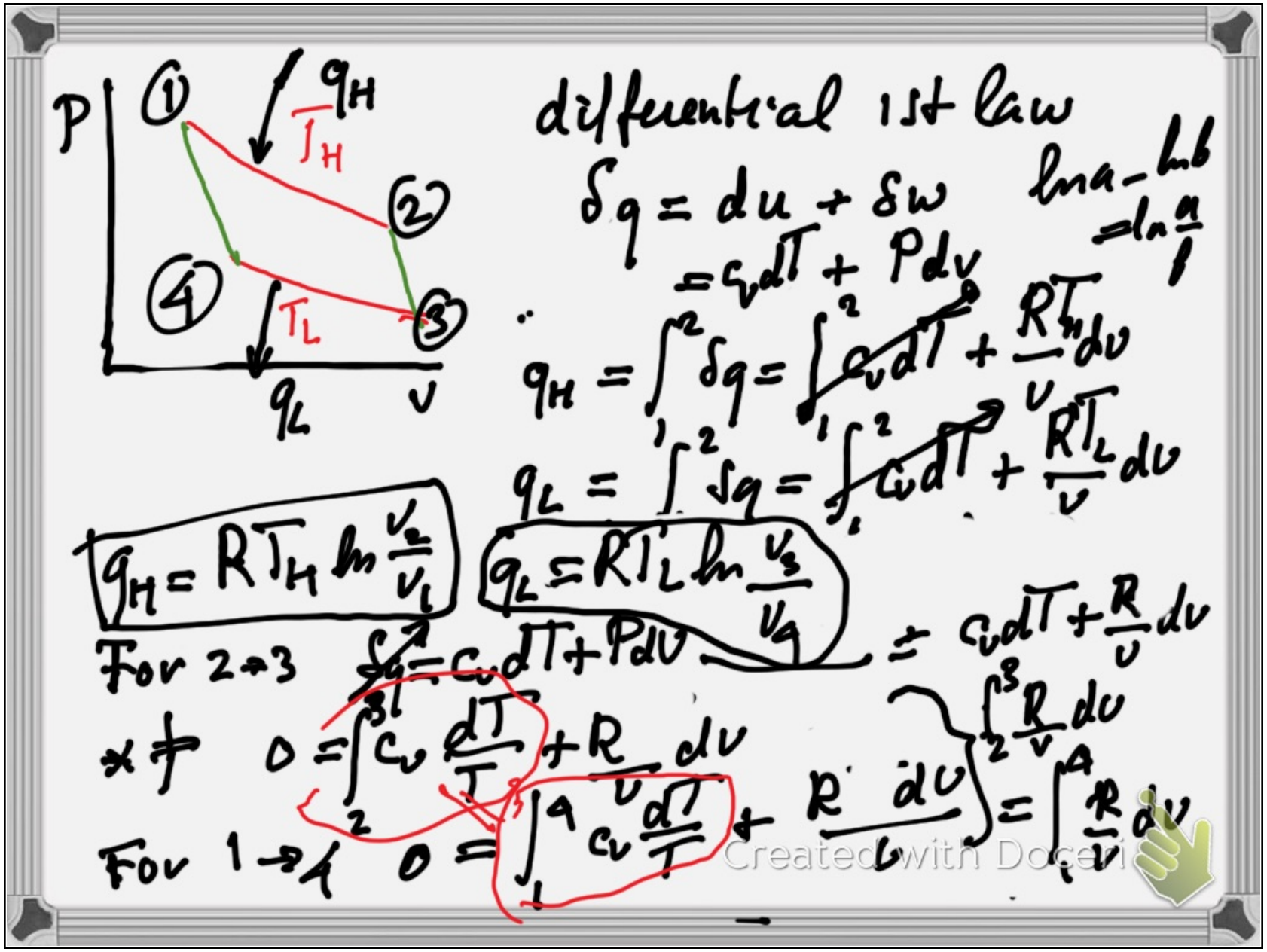
P
1
2
3
4
q_H
T_H
T_L
q_L
v
differential 1st law
$\delta q = du + \delta w$
$= c_v dT + P dv$
$q_H = \int_1^2 \delta q = \int_1^2 c_v dT + \frac{RT_H}{v} dv$
$q_L = \int_1^2 \delta q = \int_1^2 c_v dT + \frac{RT_L}{v} dv$
$q_H = RT_H \ln \frac{v_2}{v_1}$
$q_L = RT_L \ln \frac{v_3}{v_4}$
For 2→3 $\delta q = c_v dT + P dv$
$= c_v dT + \frac{R}{v} dv$
$\int_2^3 \frac{R}{v} dv = \int_4^1 \frac{R}{v} dv$
$0 = \int_2^3 c_v \frac{dT}{T} + R \frac{dv}{v}$
For 1→4 $0 = \int_1^4 c_v \frac{dT}{T} + R \frac{dv}{v}$
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$$R \ln \frac{v_3}{v_2} = R \ln \frac{v_4}{v_1} \Rightarrow \frac{v_3}{v_2} = \frac{v_4}{v_1}$$

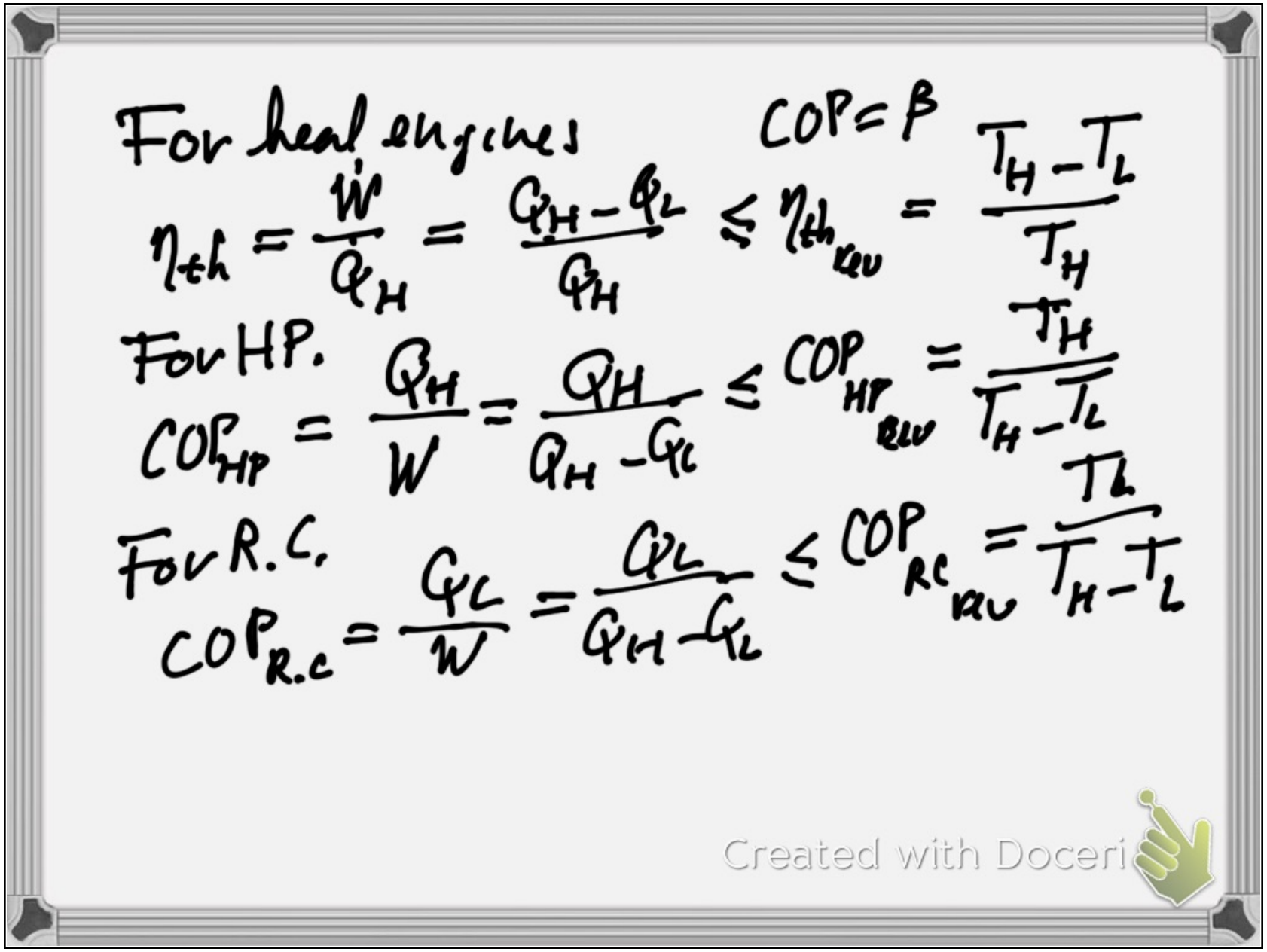
$$\frac{v_2}{v_1} = \frac{v_3}{v_4} \xrightarrow[q_L]{q_H} \frac{q_H}{q_L} = \frac{T_H}{T_L}$$

$$q_H = T_H$$
$$q_L = T_L$$

Efficiency of a Carnal Heat engine:

$$\eta_{th} = \frac{w}{q_H} = \frac{q_H - q_L}{q_H}$$

$$\overset{rev}{=} \frac{T_H - T_L}{T_H}$$


For heat engines
$\eta_{th} = \frac{\dot{W}}{\dot{Q}_H} = \frac{Q_H - Q_L}{Q_H} \leq \eta_{th_{REV}} = \frac{T_H - T_L}{T_H}$
COP ≤ β
For HP.
$COP_{HP} = \frac{Q_H}{W} = \frac{Q_H}{Q_H - Q_L} \leq COP_{HP_{REV}} = \frac{T_H}{T_H - T_L}$
For R.C.
$COP_{R.C} = \frac{Q_L}{W} = \frac{Q_L}{Q_H - Q_L} \leq COP_{RC_{REV}} = \frac{T_L}{T_H - T_L}$
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